> 2) Fail-active designs maintain an energized condition that keeps the system in a safe mode of operation until corrective action can be taken or the system is replaced by an alternate system. Redundancy using standby equipment is an example of a fail-active system.
>
> 3) Fail-operational designs allow safe continuation of function until corrective action can be taken. Fail-operational is obviously preferred, if possible. The ASME requires fail-operational feedwater valves for boilers. Water must first flow under, rather than over, the valve disk. If the disk is detached from the valve stem, water will continue to flow and allow the boiler to function normally. Designs *should be made fail-safe to the greatest degree possible.*

With regard to product warnings Hunter writes [5]:

> Designers must realize that products which lack adequate warnings or proper instructions can be legally held to be defective, even though they perform their intended function in an exemplary manner.

Further, Hunter writes that if a warning is used:

> The warning should indicate both what the hazard is and how to avoid it.

With regard to warnings the NSC writes [6]:

> Warnings must clearly describe the possible consequences, especially personal injury, of not heeding the warning, particularly when the consequences are not obvious.
>
> When safety procedures are not obvious, warnings must clearly inform the user what to do or what not to do to avoid injury.
>
> Warnings must identify all hazards that are not obvious.
>
> The sign or label must be located on the product so the warning is conspicuous.
>
> The sign or label must be constructed so it is visible and lasts for the intended life of the product.

Department of Transportation

The Federal Highway Administration's Bureau of Motor Carrier Safety published their 1974 study of truck related personal injury study which states [7]:

> The Federal Highway Administration's Bureau of Motor Carrier Safety has conducted a survey of vehicle related slip or fall type injuries in the trucking industry.

And:

> Results
>
> Slips and falls accounted for 14% of all driver personal injury accidents and 9% of all carriers' personal injury accidents.
>
> Approximately 54% of slips and fall incidents happen on the tractor or driver area and 46% happen on the trailer or cargo area.
>
> With the exception of auto transporters, which had higher incidence rate, the other 3 types of carriers had about the same rate for slips and falls per million vehicle miles, slips and falls per dispatch and slips and falls per drivers employed.
>
> Auto transporters had higher incidence rate of slips and falls per million driver man hours and higher medical and lost time costs than the other three. As could be expected the majority of injuries for the auto transporters occurred in the cargo area.

The Federal Highway Administration also stated [4]:

> The purpose of the rulemaking is to reduce the number of accidental injuries to drivers who slip and fall while performing such tasks as connecting air and electrical lines between truck tractors and semi trailers, entering or leaving cabs, and walking or climbing upon trailers, semi trailers, and cargo for the purpose of loading, unloading and inspecting cargo.

And:

> A particular troublesome problem is slips and falls from walkways and footholds designed or intended to be used by drivers and others during loading, unloading, and inspection of cargo. The problem seems to be most severe in the case of trailers and semi trailers used to haul automobiles and tank vehicles used in the solid bulk and liquid bulk hauling industries. The largest percentage of driver slip-and-fall accidents seems to occur in these categories of operations.

The Known Hazard of Falling

Over the last 50 years, accident statistics, including statistics contained in virtually every issue of Accident Facts published by the National Safety Council, indicate that excluding motor vehicle related accidents, the major cause of accidental deaths and serious injuries in the United States is fall type accidents. About 14 thousand people are killed each year as the result of falls, and countless numbers are injured. Falls are a major source of injury in the workplace, and a significant number of these falls are related to falls from workplace related vehicles.

In a 1980 California study of trucking industry work injuries, the category of "falls" constituted 16.1 % of all injuries. According to the occupation of those injured in falls, 19.9 % occurred to "truck drivers" and 14.0 % occurred to "delivery-men and route-men." According to the source of injury on those injured by falls, 82.0 % were related to "working surfaces." (National Safety Council, Accident Facts, 1982.)

As stated in a 1974 study (published in 1977) conducted by the Federal Highway Administration's Bureau of Motor Carrier Safety of the State of California statistics related to slip and fall type injuries in the trucking industry, slip and falls accounted for 14% of all driver injury accidents and 9% of all carrier's injury accidents, with 54% of such slip and fall incidents occurring on the tractor or driver area and 46% occurring on the trailer or cargo area.

In a special study conducted in 1971 by four motor carriers, at the request of the Federal Highway Administration's Bureau of Motor Carrier Safety, the following information on slips and falls was reported: The total number of driver injuries was 1,667. Of this total (1,667), 334 (20.0%) involved slips and falls, and of these, 55 (16.5%) involved cab entry/egress falls, 31 (9.3%) involved behind tractor coupling/uncoupling falls, and 248 (74.3%) involved loading or cargo related falls. Of the 55 cab entry/egress falls, 13 (23.6%) involved automobile carriers, 3 (5.5%) involved dry bulk carriers, 34 (61.8%) involved general freight carriers, and 5 (9.1%) involved bulk liquid carriers. Of the 31 behind tractor coupling/uncoupling falls, 10 (32.3%) involved automobile carriers and 21 (67.7%) involved general freight carriers. Of the 248 loading or cargo related falls, 110 (44.4%) involved automobile carriers, 135 (54.4%) involved general freight carriers, and 3 (1.2%) involved bulk liquid carriers.

The hazards of slips and falls from vehicles, including those that haul autos such as the incident vehicle were clearly understood to the industry.

Due to the generally reduced size of "walking surfaces" utilized to access industrial equipment operator and vehicle work positions, and the typical vertical movement of the body in such situations, it is vital to give special attention to the design of proper handholds and footholds in terms of size, location, orientation, and friction (slip resistance) characteristics, in order to maintain balance and stability during vehicle access and to prevent falls.

Wire Rope

With regard to wire rope United States Steel (USS) writes [9]:

> The widespread use of wire rope in almost every type of industry-and the many ramifications and variations of such service –requires constant and up-to-date knowledge of every technical advance pertaining to the construction of wire rope and to its application. To make available such information to engineers and to others who have need for exact facts relating to the subject-is the purpose of this Handbook. It is our belief that you will find the contents not only of very real help-but that you will recognize in it a broadness of scope and a completeness that could only result from knowledge gained through many years of leadership in this important field. This leadership has been achieved because of steadfast adherence to unvarying standards of quality-and because of ability to provide a perfect answer to many usual and unusual applications problems that are constantly occurring. In the future-as in the past-the vital factors that have made us the world's largest manufacturers of wire rope.

With regard to Lubrication USS writes:

> The importance of periodical lubrication is apparent from the fact that a wire rope is a machine with many moving parts. Each time a rope bends or straightens the wires in the strands and the strands in the rope must slide on each other. This requires a film of lubricant on each moving part.
>
> A second important reason for lubricating iron and steel wire ropes is to prevent corrosion of the wires and deterioration of the fiber core. There is no known means of inspection, which will even approximate the strength of a corroded rope. A rusty rope is a liability.
>
> Used ropes should be cleaned before they are lubricated.

With regard to Galvanized wire ropes, USS writes:

> Galvanized ropes have the individual wires protected by a uniform coating of pure zinc. These are used where ropes are exposed to weather, to moisture, or to other corroding agencies, and their field is usually limited to stationary installations such as guys, standing rigging, towing hawsers, mooring lines, and the like. Heavy lubricated bright ropes are generally preferred to galvanized ropes on hoisting equipment, where corrosive conditions prevail.

With regard to stainless steel wire ropes:

> Corrosion-Resistant Steel is the latest addition to the metals used for producing wire ropes. The 18 percent chromium, 8 percent nickel alloy commonly known

as "18-8" has filled the need for a corrosion-resistant wire rope for both marine and industrial use.

With regard to wire rope safety, Gator Supply Company writes [10]:

> WIRE ROPE IS A MACHINE. Understand and respect it.
> Like any machine, it needs proper care and maintenance for optimal safety and long service life. For a better understanding of wire rope we highly recommend the Wire Rope Users Manual by the Wire Rope Technical Board.

And:

> Use inspection instructions as guidelines only. Additional technical information on wire rope inspection can be obtained. Two of the most important prerequisites for inspecting wire rope are technical knowledge and **experience.**
>
> Check the general condition of the wire rope. Also, look for localized damage and wear, especially at wire rope attachments. Inspect all parts that come in contact with the wire rope. Poor performance of wire rope can often be traced back to worn or wrong-sized sheaves, drums, rollers, etc. Look for kinks, broken wires, abrasions, lack of lubrication, rust damage, crushing, reduction of diameter, stretch or other obvious damage. If **any** of these conditions exists or if there is any other apparent damage to the wire rope, retire the wire rope according to the instructions below.
>
> When in doubt about the extent of the damage, retire the wire rope in question immediately. Without laboratory analysis, it is **impossible** to determine the strength of damaged or used wire. Thus, you will not be able to tell whether wire rope with any amount of damage is safe to use. Retire the wire rope that is damaged. For specific inspection procedures check various OSHA and ANSI publications.

The Associated Wire Rope Fabricators is the association that sponsors the Wire Rope Users Manual, and the Wire Rope Technical Board. The Association supplies the following warning, which appears in color in figure 1 [11]:

The warning is dated 1993, by the Wire Rope Fabricators.

With regard to lubrication the WRCA writes [12]:

> **Lubricate ropes often for long life.** To properly maintain your rope, the first place to check is for obvious signs of abuse from other parts of the rope system. But the biggest part of maintenance involves regular lubrication to reduce friction between the rope's components as well as the friction between rope and sheaves or drums.
> Your rope receives internal lubricant at the factory, but it's not enough to last the rope's entire life due to constant bending over sheaves and drums. The need to keep your ropes properly lubricated can't be emphasized enough.
>
> **Clean ropes first.** Remove excess dirt, rock, dust or other materials that can prevent field-applied lubricants from properly penetrating into the ropes.

With regard to rope inspection, removal and possible causes, Unirope writes [13]:

Fault	Possible Cause
Corrosion	Inadequate lubrication, Improper storage, Exposure to acids or alkalis.

And:

Wire Rope Inspection
An inspection should include verification that none of these removal criteria are met by checking for such things as:

Surface wear, normal and unusual
Broken wires: Number and location
Reduction in Diameter
Rope stretch (elongation)
Integrity of attachments
Evidence of abuse or contact with other objects
Heat damage
Corrosion

With regard to Galvanized Cable, in particular 7x19(the incident size), Unirope writes:

These small diameter cables are made from carbon steel and are drawn galvanized. If used outdoors, the galvanizing protects the cable from corrosion for a period of time but will discolor to a white or dull appearance. Prolonged exposure to the elements will eventually cause corrosion.
Cables which are required to be coated and which are subjected to sheaves and pulleys should be made with a hard Nylon coating instead of the relatively soft PVC coating. Ask for details.

Further they provide the following warning again relevant to Galvanized Cable, in particular 7x19:

CAUTION
DO NOT use these cables
in any aircraft or similar
application

Corrosion Failures

A preventive maintenance program is essential for the safety of a safety cable assembly throughout its entire service life. A failure in a component of this assembly will often lead to the complete failure of the assembly. An adequate preventive maintenance program will require that all componentry in the safety cable and rail connection, including the bolting, be visually inspected and repaired or replaced if necessary.

To this subject DAS writes [14]:

> Services failures are not uncommon due to abnormally severe conditions of speed, loading, temperature and chemical environment. Absence of scheduled maintenance, inspection and monitoring are the causes of such failures. There are different types of deterioration associated with the failure system and these are given below.

Defect	Effect
Wear-adhesive and abrasive type	Causes dimensional deviation, introduces stress-concentration and susceptibility to fatigue.
Corrosion-oxidation, pitting and and intergranular corrosion	Causes dimensional deviation stress concentration and reduces strength and fatigue resistance. .....
Inadequate/bad maintenance and improper repair.	Results in premature failure or undetected defects during overhaul.

Trailers are commonly subjected to the severe conditions of repeated loading, roadway vibration, and chemical attack from chemicals and moisture. The deterioration of the safety cable to swage fitting joint takes time. Photos reviewed reveal rust on the trailer body and it's underside. As the trailer ages, the effects of time and use require increased preventive maintenance.

Allied Safety Meetings

A review of safety meeting minutes and internal documents reveals the following comments with regard to Allied's knowledge with regard to safety cable problems.

1) 3/11/1999 - Will bring up cable issues on 3200 equipment.

2) 3/30, 3/31 - What is the policy on replacing the "clothes-line"?

3) 4/13/1999 – "clothesline" will be replaced as requested. All drivers should check their's, and if the plastic is cracked or there are any signs of rust, have them replaced.

4) 4/12/1999, 4/29/1999, 4/30/1999 – Check your clothes lines. If you see any problems (plastic pulling away, rusting, etc) have them replaced. If you are not sure, have Bill or the shop check them.

5) 5/18/1999, 5/19/1999 – One driver shopped truck for clothesline replacement and we were out. (We can get extra from Marion.)

6) 9/7/1999 – Moraine will be a test site for new "chain" clothesline to be used on the head ramp. The chains will be adjustable, and should eliminate the problems we've had due to weakened cables. Phil Kuchar suggested that all trucks be refitted.

7) 9/21/99, 9/24/1999 – We had previously announced we would be a "test site" for the new safety chains for the head ramp. This issue has been placed on hold for the time.

8) 10/13/1999 – Clotheslines will not be retrofitted onto trucks. We will continue to replace them as required.

9) 9/7/2000 - inspecting and replacing as needed per Gordon will speak to B. weaver Rick said he only replaces what Bill tells him to. They (he) does not inspect for problems.

10) 9/30/2000 – A discussion was brought up on the replacement of safety cables for trucks. The shop is actively replacing all safety cables as they become available.

Prior Incident

The Ferguson incident is not the first notice to Allied that driver's were being injured from falls related to a failed safety cable. Thomas Fay had a fall with circumstances similar to that of Ferguson on 8/8/2000. The Employee Statement of Accident/Injury for the Fay incident reads:

> I was loading my truck chaining down #1 Unit on the head ramp. Leaned on the safety cable for balance while chaining. Cable snapped + I went flying off the head ramp to the black topped driveway, approximately 8 to 9 feet below.

Deposition Testimony of Richard Shivley

Shivley testified that he was a mechanic at Allied. Further that he knew that the safety cables were failing at the point where the cable goes into the swaged fitting. Shivley testified:

A. Where the braiding goes into the swedging.

Q. That's where they would break?

A. Yes, sir.

Q. Okay. And what period of time did you replace these six that were broken?

A. I was on a voluntary layoff for a while. I came back to work to the Moraine facility in May '99.

Q. Okay.

A. And they were replacing them at that time, during that summer, I remember.

Shivley Pg. 9

Shivley testified that he could not swear to the replacement of safety cables into the year 2000.

With regard to the fact that all the cables need to be replaced, Shivley testified:

Q. Who was it that told you that they all needed replacing?

A. I would say Bill Weaver.

Shivley PG. 31

Shivley testified that he did not receive any instruction or training with regard to the maintenance of the safety cables. Further Shivley testified:

Q. Mr. Winter asked you whether you received any instructions from outside of the company about how to maintain the cables like this. You said there weren't any. Do you consider it good practice as a mechanic with 25 years' experience to do something to maintain, protect or replace galvanized parts that are exposed to the elements?

Mr. Larson: Objection to form.

A. No, sir.

Q. Are you aware that galvanized parts may deteriorate and reflect out in the elements?

Mr. Larson: Objection to the form.

A. No, sir.

Shivley Pg. 37

Deposition Testimony of Fredrick L. Wolf

Wolf testified that he was a mechanic at Allied. With regard to the replacement of safety cables, Wolf testified:

Q. ... First of all, were all the safety cables being replaced on all of the trucks?

A. I'm not sure. There was no policy that I know of. I mean, we were replacing them as they came in.

Wolf Pg. 9

And:

Q. Let's imagine they were in stock. If four came in that day, that truck sitting there, you're working on something, you replace all four cables?

A. Yes, before we release the truck, as per instruction of my boss.

Wolf Pg. 10

Wolf testified that they were just replacing cables on trucks that happened to be in the shop for other maintenance and only if they had cables to use. To this point Wolf testified:

Q. Now if you didn't have enough for four, any particular order you used to replace them? Did you replace top ones, bottom ones, or anything like that?

A. To my recollection, we were instructed to replace top ones if we only had two.

Wolf Pg. 32

Deposition Testimony of William C. Weaver

Weaver testified that he was the maintenance manager at the Moraine facility of Allied. Weaver testified that in January, February of 1999, by way of conference call between the maintenance managers and a Mr. Tagget, the maintenance managers in Indiana, Michigan and Ohio were ordered to replace all safety cables specifically because they were breaking. Further, Weaver testified that they were told to do this right away. With regard to the conference call with Tagget, Weaver testified:

Q. And so he said we have a cable problem?

A. Yes, sir.

Q. Did he say what the problem was?

A. Yes, sir.

Q. What did he say?

A. He said there was a rust problem on a cable between the plastic and the joint and fixture, at the crimp, and that we were to replace. And when we took the old ones off, we were to cut them up, destroy them, put them in the trash so they would not be reused.

Q. So you were to replace them all?

A. Yes, sir. There wasn't any question about it, we replaced them.

Weaver Pg.'s. 13 &14

And:

Q. Okay. And so up until August and at least September 2000, some of the trucks had still not had new cables put on them, correct?

A. I don't know about the other installations. Mine was taken care of.

Q. But Mr. Ferguson still had an old cable on it, correct?

A. I - - according to these pictures, yes.

Weaver Pg. 19

With regard to inspecting for any problems, Weaver testified:

We were not inspecting. The driver would tell us. We did not just go, per se, and inspect and say, well, that's a bad cable. We were instructed to replace. That's what we did when we had the cables to replace them with.

Weaver Pg. 20

Weaver testified that if they did not have sufficient cables to completely change all four on a single vehicle that they would change out the bottom ones:

That's because they are in a cross-position when they are working up there.

Weaver Pg. 34

Weaver testified that he had seen stationary handrails on other equipment.

With regard to retaining incident parts Weaver testified:

Q. So it's standard procedure, proper procedure to hold the parts that were involved in an accident?

A. Yes, sir.

Weaver Pg. 40

Deposition Testimony of William C. Hanes

Hanes testified that he was the owner of Hanes Supply Inc. Further that he was involved in the sales of the initial cables to CCI.

With regard to the cable specifications Hanes testified that:

I told them what was available. It was - - it was up to their call.

Hanes Pg. 26

And:

It was their choice. They were - - it's their choice to utilize the material they felt was appropriate.

Hanes Pg. 44

Further, Hanes testified that CCI, not Hanes, chose the specification for the swaged fitting, the material specification, and the coating for the material. Hanes testified:

Q. Okay. To your Knowledge, did anyone at your company give them advice or recommendation on what type of material to use, what coating to use, what diameter to make the safety cable, whether it be PVC, nylon, galvanized steel, stainless steel? Did anyone in your company make a recommendation to them?

A. No.

Hanes Pg. 46

Finally, Hanes testified that at about 1999 CCI changed the design of the safety cable to a thimble and threaded eyebolt.

With regard to the life of the product, Hanes testified:

Q. Okay. Did you know how long these safety cables were supposed to last?

A. No.

Q. Did you give them any instructions on replacement of them?

A. The instructions would be the standard warnings on our work order invoices.

Hanes Pg. 47

The warning reads:

Product Warning: Wire rope products, slings and lifting equipment will break if abused, misused or overused. Regular inspection and maintenance before and after use is necessary. Consult industry recommendations and standards before using.

With regard to problems with the product, Hanes testified:

Q. Okay. The only thing at issue is the wire itself?

A. I don't think the wire itself. The wire is fine. Got to be inspected.

Q. But it's my understanding that you didn't tell the people at Commercial Carriers, Inc. anything about inspecting the cables, other than your one warning on your invoice, correct?

A. We have the warning on there, and the end user has to take it upon themselves if he sees corrosion or some type of deformation in the product to remove it from service.

Q. Okay. And you didn't give them an opinion as to how long the product would last?

A. No.

Hanes Pg.'s 67 & 68